

## Ben 2 and Ben 3 – Fuelwood Stoves

### Annex B)

### Description of the Devices for Serial Production

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#### 1. General

The stoves Ben 2 and Ben 3 are intended to be produced in small local workshops with locally available material (sheets, rods and strips made of mild steel), using simple tools, where required only with hand-held equipment. For production in small series the presented devices may be helpful.

Annex C) and Annex E) contains the drawings, Annex D) and E) shows photos of the devices for the production.

Devices are described for production of fuelwood stove Ben 2 for pots with a diameter up to 28cm and stove Ben 3 for pots from 28cm to 32cm and also for larger pans and woks.

Figures in round brackets ( ) refer to the pieces numbered in circles in the drawings, Annexes A) and C), e.g. (2) for the grate bar, and to the pieces numbered in the drawings of the devices (D1) to (D10), e.g. (D3b) for the template for bending the stove shell at drawings (D3) and (D3').

Linear measures are given in mm.

## **2. Device (D1) for bending the ash pan (1)**

The ash pan has two bends (71° for Ben 2, 60° for Ben 3) which are produced after drilling the holes (with device (D7)) for passing the grate bars. A foldable work bank (X) is enforced with two edge trims (D1a) and (D1b). The bending lines are marked with a marker along a ruler (400 mm x 80 mm). Between the trims the prepared steel sheet (1) is clamped and bent by hand. The bending angle is determined and controlled with the template (D1d). The short side of the template (D1d) is gripped with the edge trims besides the steel sheet to be bent. The use of work gloves is recommended.

Before bending, the edges of the steel sheet (1) are to be deburred and the corners are to be rounded. The corners of a stack of steel sheets (1) can be rounded simultaneously with a flat file.

Device (D1) serves for bending ash pans with a length of 400 mm, limited by the foldable work bench. Longer ash pans can be bent with two long angle steels clamped in the bench vice. Of course an extension is possible with an additional trough.

## **3. Device (D2) for bending the grate bars (2)**

The grate bars (round steel diameter 6 mm or threaded rods M6) are bent in form of a hairpin. This enables to lock them in the 8 mm holes of the ash pan. The bars (length 297 mm for Ben 2 and 331 mm for Ben 3) are bent around the roll (D2a), counter supported with the cylindrical head of the hexagon socket screw (D2d). The bending by hand can be relieved with a steel-tube (500 mm x 10 mm x 1 mm or 500 mm x 12 mm x 1.5), used as lever. The angle of the grate bars causes a pretension when the bars are installed, ensuring that they do not drop out.

Instead of the roll (D2a), assembled washers may be used. This alternative is shown in drawing (D2'). This drawing shows also alternatives for the socket head screw (M6, head diameter 10 mm) through a screw M6 with Philips head (cross head screw) and washers with the diameter of the Philips head (12 mm).

## **4. Device (D3) for bending the stove shell (3)**

The stove shell (3) is bent stepwise with the help of device (D3) which is installed on the foldable work bank (X). The shell is gripped by the two boards of the work bench. Before bending, the holes of the stove shell are drilled with the help of device (D8). The rounded form is completed when the ends of the stove shell are screwed together. To simplify the transport, bending of shell can be done in local assembly work shops with device (D3).

On both ends of the stove shell the shell port is prepared by a cut with a sheet metal shear. The tab of the port (97 mm x 60 mm for Ben 2, resp. 115 mm x 60 mm for Ben 3) is bent and pressed onto the shell. This provides rounded port sides.

Device (D3) is also suitable for bending the stove shell for pans and large pots. This stove shell has a width of 150 mm.

The stove shield (5a), for shielding the hot stove shell, can be bent with device (3), too.

*Devices (D5), (D6), (D7), (D10) and (D11) are replaced due to the recommended tripod (4W) made of round steel. Annex E) contains the documentation of tripod (4W) including its production.*

#### **5. Device (D4) for bending the tripod legs (4b); replacement see Annex E)**

*To bend the strip steel (20 mm x 3 mm) of tripod leg (4b) a stable steel bench vice is used. The tripod legs are the same for Ben 2 and Ben 3. Device (D4) is clamped with the jaws (Z) of the bench vice. The device comprises a hinge band (D4c) with the appropriate curvature (24 mm diameter). The strip steel is clamped to the hinge band through two square tubes. For easy handling of device (D4) the components are screwed together. The tripod leg (4b) is bent by hand, fortified by a lump hammer.*

*The clamping length is provided in device (D4) with distance plates (e.g. aluminium). There are 2 clamping lengths: 21 mm (for bending the upper end of the tripod leg) and 41 mm (for the tripod foot where the stove shell is supported). There is a small distance plate (D4i), attached to the device with a string, to provide for the difference of 20 mm between 41 mm and 21 mm.*

*The first bend is performed with clamping the 21 mm for the upper end of the tripod leg. Then the opposite end is bent to pre-form the foot of the tripod leg (please observe the right bending direction). For this bend, the strip steel is clamped with 41 mm length. Device (D4) enables a bend of about 160°. On the anvil of the bench vice the angle is increased using the lump hammer. Before completing the bend of 180°, the second bend at the foot of the tripod leg is realised with the help of device (D5).*

#### **6. Device (D5) for the second bend of the tripod foot; replacement see Annex E)**

*For the second bend at the foot of the tripod leg, the pre-bent foot is clamped with the jaws (Z), together with device (D5) of the bench vice. The strip steel is bent by hand, fortified by a lump hammer. The ultimate shape of the foot is accomplished with the hammer. The position with hole (6.5 mm) should be clamped with the jaws (Z) when bending the 10° bend for finishing the tripod foot. The shape of the tripod-foot is controlled with the drawing (4b).*

#### **7. Device (D6) for bending the tripod ring (4a); replacement see Annex E)**

*The device (D6) is suitable for the tripod ring of Ben 2 and Ben 3. The tripod ring is bent after drilling the 6.5 mm holes (5 holes) with drilling device (D10). Device (D6) is a template (embedded in the bench vice) for stepwise rounding the strip steel of the tripod ring. A weld seam at the position marked in the drawing will enforce the template. The rounding is done by hand, fortified by a lump hammer. The positions with holes (6.5 mm) should be clamped with the jaws (Z) when bending the ring. After rounding the ring, the ends are screwed together.*

*To avoid self-loosening of the nuts after tightening the bolted connections of the tripod, the screw threads are "damaged" with a centre point at the position where the thread of the screw comes out of the nut (see last photo in section 4. of Annex D).*

#### **8. Device (D7) for drilling the holes of the ash pan (1)**

The positions of the holes are the same for Ben 2 and Ben 3 (deviating from earlier drawings). The holes of the ash pan are drilled in device (D7) before bending the ash pan in device (D1). To produce device (D7) a wooden base board (D7a) is plated with a steel sheet (D7c) and equipped with arresters (D7b) for positioning of the steel plate (400 mm x 250 mm x 0.75 mm) of the ash pan (1).

A number (of e.g. 3) mild steel plates (1) can be drilled jointly. For positioning of the centres of 8 mm holes, the template (D7d) provides 4 mm holes which are used for punch marking the centres of the holes. After

introducing the steel plates (1) into device (D7), the template (D7d) is placed on top of them. After punching of appropriate deep centres for the 8 mm holes, the template (D7d) is removed. The pressure pieces (D7e) are actuated by 4 star knobs resp. wing nuts before drilling the 8 mm holes with a handle drill at the punch marked centres. This avoids the risk that the plates (1) leave their arrested position.

To avoid risk of injuries through the sharp edges of the square tubes, the pressure pieces are capped at the ends with plastic plugs (D7j) or carefully rounded with a flat file.

Drawing (D7') shows wing nuts (D7j) as alternatives to the star knobs (D7f) and rack rails (D7m) as alternatives to the square tubes (D7e). The socked head screws (D7b) can be replaced by Phillips head screws combined with washers, considering the different outer diameter (12 mm instead of 10 mm).

### **9. Device (D8) for drilling the holes of the stove shell (3)**

Device (D8) corresponds to device (D7). Instead of 8 mm holes, the diameter of the holes in the stove shell is 6.5mm. The holes of the stove shell are drilled in device (D8) before bending the shell in device (D3). To produce device (D8), a wooden base board (D8a) is plated with a steel sheet (D8c) and equipped with arresters (D8b) for positioning of the steel plate (1000 mm x 200 mm x 0.75 mm) of the stove shell (3).

A number (of e.g. 3) mild steel plates (3) can be drilled jointly. For positioning of the centres of 6.5 mm holes, the template (D8i) provides 4 mm holes which are used for punch marking the centres of the holes. After introducing the steel plates (3) into device (D8), the template (D8h) is placed on top of them. After punching of appropriate deep centres for the 6.5 mm holes, the template is removed. The pressure pieces (D8d), are actuated by 4 star knobs or wing nuts, before drilling the 6.5 mm holes with a handle drill at the punch marked centres. This avoids the risk that the plates (3) leave their arrested position. The pressure pieces (D8d) are arranged pivoting, so that the star knobs resp. wing nuts have not to be removed, but only unfastened.

To ensure the right position of the cut for the shell port, 4 mm holes are drilled also at the inner endpoints (115 mm, 60 mm) of the cut. The holes in the shell with 150 mm width (D8h') for pans and larger pots can also be drilled in device (D8). The appropriate holes (4 mm) for punch marking the centres are provided in the template (D8h). For controlling the right position of the 150 mm-shell, there are 2 holes with 7 mm diameter in template (D8h).

### **10. Device (D9) for drilling the hole in the tripod leg (4b); *replacement see Annex E***

*The holes in the tripod legs and the tripod ring are produced in the flat strip steel (20 mm x 3 mm). Each tripod leg has one hole of 6.5 mm diameter. This can be drilled or punched. The device (D9) for drilling the hole consists of a wooden base board (D9b) plated with a steel sheet (D9c), equipped with arresters (D9a) at the sides and ends of the unbent tripod leg material. A pressure piece (D9g) guides the 6.5mm-drill and presses the tripod leg. The pressure piece is actuated by 2 star knobs or wing nuts.*

*For reasons of safety the device (D9) has to be fastened on the work bench (Y) with 2 screws M6 and also the pressure piece (D9g) has to be fastened safely before drilling.*

*The pressure piece (D9g) is arranged pivoting, so that the star knobs resp. wing nuts have not to be removed, but only unfastened for handling the strip steel (4b).*

### **11. Device (D10) for drilling the holes of the tripod ring (4a); *replacement see Annex E***

*Before rounding the strip steel for shaping the ring (4a) in device (D6), the straight strip steel is provided with 5 holes (6.5 mm). These can be drilled or punched. The device (D10) for drilling consists of a wooden base board (D10b) plated with a steel sheet (D10c), equipped with arresters (D10a) at the ends and sides of the flat ring material. A template (D10i) with 4 mm holes is pressed with 2 pressure pieces (D10g) against the strip steel (4a), actuated by 2 star knobs resp. wing nuts. The strip steel (4a) is pre-drilled with 4 mm holes. Afterwards the pressure pieces are unfastened and the template (D10i) is removed. Then the holes are drilled with a 6.5 mm drill at the pre-drilled (4 mm) holes without using a template, but with the safely fastened pressure pieces (D10g).*

*In drawing (D10) figures k, m, and n are used for the dimensions which are to be adapted for Ben 2 and Ben 3 according the lengths (mm) given in the table on the left side of (D10). For reasons of safety the device (D10) has to be fastened on the work bench (Y) with 2 screws M6 and also the 2 pressure pieces (D10g) have to be fastened safely before drilling. The 2 pressure pieces (D10g) are arranged pivoting, so that the star knobs resp. wing nuts have not to be removed, but only unfastened for handling the strip steel (4a).*

## **12. Information regarding the Annexes**

Annex A) shows a shield (5) which may be attached to the stove shell to reduce danger of burns. The shield parts (5a) and (5b) can be bent with devices (D3) and (Z).

The drawings in Annex C) show devices for production of the stoves for pots with a diameter up to 30 cm. With 1000 mm length of sheet material a stove shell with diameter 314 mm (15 mm overlapping) can be produced, fitting for pots with 30 cm diameter.

For pot diameters used in stove Ben 2 the dimensions of the devises should be adapted, using corresponding templates and sheet material lengths according the drawings of the stove shell.

Instead of drilling the holes, they may be punched. A hand lever punching device has the advantage of not depending on electric power supply.

Annex E) shows the details of the tripod (4W) made of round steel and its production.

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